Chapter Five: Reasonably Foreseeable Effects of Licensing and Subsequent Activity

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Oil and gas exploration, development, production, and associated support functions occur across portions of Alaska's North Slope, the Beaufort Sea and in the Cook Inlet region. Each year government agencies, industry, and the public are better able to recognize and anticipate impacts and to institute measures, which will reduce or eliminate those impacts. As a result, much progress has been made in promoting efficient operating practices and minimizing effects on the environment and its valuable fish and wildlife resources.

Until discoveries are made, it is impossible to predict the actual level of oil and gas activities and their effects. DO&G cannot predict when any activity might occur or the type, location, duration, or level of any oil or gas activities and, therefore, it is impossible to predict the potential effects of all possible activities. Strategies used to explore for, develop, produce, and transport petroleum resources will vary, depending on factors unique to an individual situation. Implementation of any exploration and development program must meet the requirements of regulatory agencies prior to approval. Permit requirements must be evaluated in light of the particular activity proposed, and plans of operation must be approved with appropriate project-specific and site-specific safeguards.

The state's resource agencies have developed general mitigation measures to minimize pollution and habitat degradation, and disturbance to fish and wildlife species, subsistence users, and local residents. In addition, project-specific and site-specific mitigation measures will be applied to particular exploration and development proposals. Despite these protective measures, some impacts may occur. In this section, potential impacts are discussed, and measures to mitigate these impacts are presented. See Chapter Seven for mitigation measures and licensee advisories.

Strategies used to explore for, develop, produce, and transport potential petroleum resources will vary, depending on factors unique to the individual license area, licensee, operator, or discovery. If a commercially developable deposit were found, any development would require construction of one or more drillsites. If resources can be developed, construction of pipelines would be likely, and other production and transportation facilities would also be necessary. Some new roads may be required, and machinery, labor, and housing would be transported to project sites.

The state of Alaska as a whole, the Denali Borough, the Fairbanks North Star Borough, and the communities of Nenana, Minto, and Anderson, may experience effects of activities in both monetary and non-cash terms. Potential effects are listed in Table 5.1.

Most adverse effects would be temporary and may occur during development, and not during exploration and production phases. Positive effects occur at all phases and fiscal benefits of petroleum extraction may last several decades. All licensing activities are subject to applicable local, state, and federal statutes, regulations, and ordinances, and subject to mitigation measures. Implementation of any exploration and development program must meet the requirements of regulatory agencies prior to approval. Permit requirements must be evaluated in light of the particular activity proposed, and plans of operation must be approved with appropriate project-specific and site-specific safeguards.

Table 5.1: Potential Effects of Oil and Gas Exploration

Erosion	Water quality changes
Use conflicts	Chemical/pollutant releases
Disturbance to wildlife	Impacts to human environment
Oil spills	Air quality degradation
Alteration of hydrology	Siltation
Loss of fish and wildlife	Employment opportunities
Increased noise and traffic	Road, dock, airstrip, sanitary & utilities construction
Habitat loss or change	State petroleum tax & royalty revenues
Environmental studies	Local oil and gas property tax revenues

A. Post Licensing Phases

License-related activities proceed in phases; each subsequent phase's activities depend on the completion or initiation of the preceding phase. Table 5.2 lists activities that may occur during these phases.

1. Exploration

The purpose of exploration is to gather as much information about the petroleum potential of an area as possible. Exploration activities may include the following: examination of the surface geology, geophysical surveys, researching data from existing wells, performing environmental assessments, and the drilling of an exploratory well. Surface analysis includes the study of surface topography or the natural surface features of the area, near-surface structures revealed by examining and mapping exposed rock layers, and geographic features such as hills, mountains and valleys.

a. Geophysical Exploration

Geophysical companies usually conduct seismic surveys under contract with license holders. Geophysical exploration activities are regulated by 11 AAC 96, and ADNR tailors each permit approval to the specifics of a proposed project. Restrictions on geophysical exploration permits depend on the duration, location, and intensity of the project. They also depend on the potential effects the activity may have on important species or human use, such as migrating salmon. The extent of effects on important species varies, depending on the survey method and the time of year the operation is conducted.

Geophysical surveys help reveal what the subsurface may look like. Before they proceed, companies must acquire one or more permits from the state, depending on the timing and extent of the proposed activity. Companies will gather two-dimensional (2-D) and possibly three-dimensional (3-D) seismic data. Two-dimensional seismic programs usually have fewer crewmembers and employ less equipment than 3-D programs.

Land-based seismic surveys are typically conducted in winter. To gather seismic data, an energy source is required to generate energy waves that travel into the subsurface. Depending on the difference in densities of the layers of rock beneath the surface, these energy waves are reflected back from the various rock layers and are received by vibration-sensitive devices called geophones. Impulses are recorded on computer tape, processed on high-speed computers, and displayed in the form of a seismic reflection profile.

Geophysical companies use various methods of generating energy, depending on the terrain and conditions. These methods might employ explosives, Vibroseis, or the dropping of weights, to name a few. Explosives may be placed into drill holes and detonated, or they may be suspended on stakes above the ground (Poulter method). If buried, drill holes are typically 15 to 25 feet deep with 5 pounds of explosive set at the bottom of the hole. The drill holes are drilled with either track-mounted drills or, if in remote or sensitive areas, slung into position by helicopters. Vibroseis utilizes a vibrator as the energy source. The vibrating plate is attached to a low ground pressure tracked vehicle, and creates a sinusoidal vibration of continuously varying frequency, typically lasting seven seconds or longer. Weight dropping can be accomplished through the use of specially designed vehicles or with helicopters. Because of its relatively remote location, terrain and varying vegetation cover, several energy source techniques might be needed within the Nenana basin. As discussed in Chapter One, all seismic surveys must go through the permitting process. For surveys within the MSFGR, the activity must be approved by both ADNR and ADF&G.

Table 5.2 Exploration, Development, and Production Phase Activities

Exploration	Development	Production
permitting	gravel pits, pads, and roads	well workover (rigs)
water usage	dock & bridge construction	gravel pads and roads
environmental studies	drilling rigs	produced water
seismic tests	pipelines	air emissions
exploratory drilling	work camps	pipeline maintenance
land clearing	permitting	work camps
drilling muds & discharges	monitoring	trucking
gravel road beds	well heads	
work camp	reinjection wells	
increased air traffic		
temporary gravel pads		
permitting		
environmental studies		
research and analysis		

b. Exploration Drilling

Exploratory drilling only occurs after seismic surveys are conducted, and only if interpretation of the seismic data reveal oil and gas prospects. The only way to learn whether or not a prospect contains commercial quantities of oil or gas is by drilling. Exploratory drilling generates information for the licensee, which will aid in the decision whether to proceed to the development phase. Drilling operations collect core samples, well logs, cuttings, and various test results. Cores may be cut at various intervals so that geologists and engineers can examine the sequences of rock that are being drilled. A well log is a record of one or more physical measurements as a function of depth in a borehole, and is achieved by lowering various instruments into the well bore.

If the exploratory well is successful, the operator will probably drill one or two more wells to delineate the extent of the discovery and gather more information about the field. The licensee needs to know how much oil and gas may be present, and must determine the quality of the rocks in which they are found to determine whether or not to proceed to the next phase.

The drilling process is as follows:

- Special steel pipe, conductor casing, is bored into the soil.
- The bit rotates on the drill pipe to drill a hole through the rock formations below the surface and into the earth.
- Blowout preventers are installed on the surface and only removed when the well is plugged and abandoned. Blowout preventers are large, high-strength valves, which close hydraulically on the drill pipe to prevent the escape of fluids to the surface.

- Progressively smaller sizes of steel pipe, called casing, are lowered into the hole and cemented in place to keep the hole from caving in, to seal off rock formations, seal the well bore from groundwater, and to provide a conduit from the bottom of the hole to the drilling rig.
- The well either produces, is capped, or is plugged and abandoned.

An exploratory drilling operation generates approximately 12,000 cubic ft. of drilling solids. Cuttings are fragments of rock cut by the drill bit. These fragments are carried up from the drill bit by the mud pumped into the well (Gerding, 1986: 97-174). Also produced from drilling operations are gas, formation water, and fluids and additives used in the drilling process. The fluids pumped down the well are called mud, and different formulations are used to meet the various conditions encountered in the well. Muds are naturally occurring clays and small amounts of biologically inert products. They cool and lubricate the drill bit, prevent the drill pipe from sticking to the sides of the hole, seal off cracks in down-hole formations to prevent the flow of drilling fluids into those formations, and carry cuttings to the surface.

The state discourages the use of permanent reserve pits, and most operators store drilling solids and fluids in tanks until they can be disposed of, generally down the annulus of the well, in accordance with 20 AAC 25.080. Frozen cuttings may also be temporarily stored on the pad. In most circumstances, the cuttings are transported to a grind and inject facility. If necessary, a flare pit may be constructed to allow for the safe venting of natural gas that may emerge from the well. If the exploratory well discovers oil or gas, it is likely that the pad used for the exploratory well will also be used for production testing operations.

Mitigation Measure 17b regulates the disposal of muds and cuttings. The preferred method for disposal of muds and cuttings from oil and gas activities is by underground injection. Injection of non-hazardous oil field wastes generated during development is regulated by AOGCC through its Underground Injection Control (UIC) Program for oil and gas wells. Annular disposal of muds and cuttings associated with drilling an exploratory well is permitted by AOGCC. Surface discharge of drilling muds and cuttings into lakes, streams, rivers, and high value wetlands is prohibited. Surface discharge of drilling muds and cuttings into reserve pits shall be allowed only when the Director, in consultation with ADEC, determines that alternative disposal methods are not feasible and prudent. If use of a reserve pit is proposed, the operator must demonstrate the advantages of a reserve pit over other disposal methods, and describe methods to be employed to reduce the disposed volume. Onpad temporary cuttings storage will be allowed as necessary to facilitate annular injection and/or backhaul operations.

Mitigation Measure 18 regulates the disposal of produced water and other wastewater. Disposal of produced waters in upland areas, including wetlands, will be by subsurface disposal techniques. ADEC may permit alternate disposal methods if the licensee demonstrates that subsurface disposal is not feasible or prudent. Surface discharge of reserve pit fluids will be prohibited unless authorized by ADEC permit and approved by DMLW.

2. Development and Production

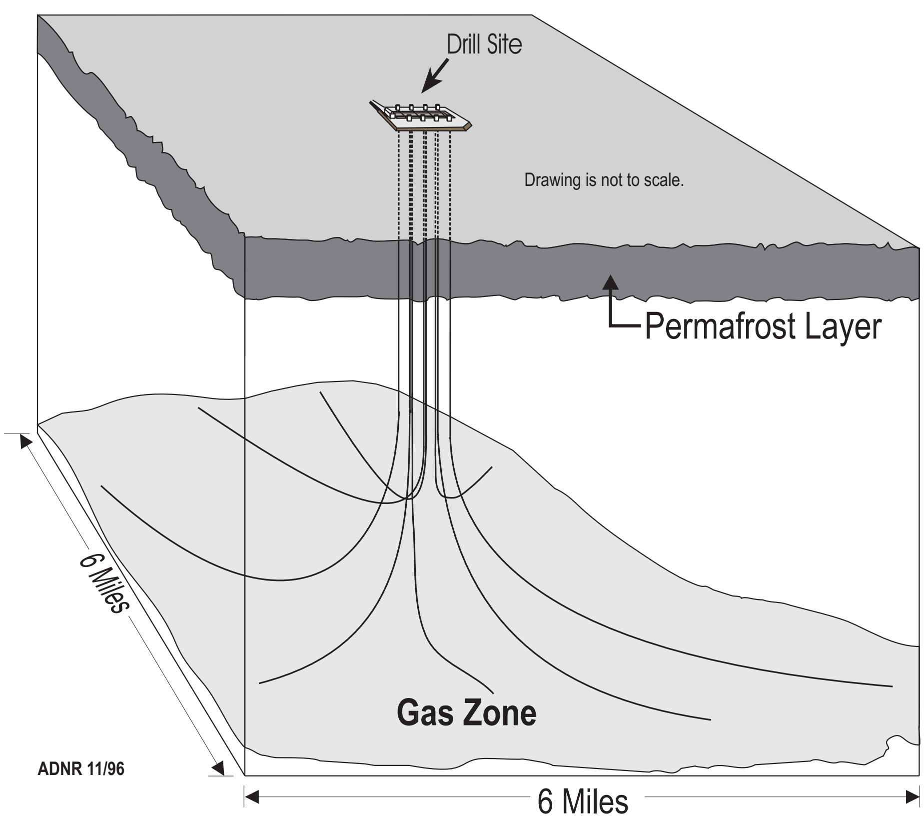
The development and production phases are interrelated and overlap in time; therefore, this section discusses them together. During the development phase, operators evaluate the results of exploratory drilling and develop plans to bring the discovery into production. Production operations bring well fluids to the surface and prepare them for transport to the processing plant or refinery. These phases can begin only after exploration has been completed and tests show that a discovery is economically viable (Gerding, 1986).

After designing the facilities, the operator constructs permanent structures and drill production wells. The operator must build production structures that will last the life of the field and may have to design and add new facilities for enhanced recovery operations as production proceeds. Gravel pads are semi-permanent structures used for production facilities and can be rehabilitated following field depletion. Production operations for natural gas generally consist of the following processes:

- Natural gas flows through a high-pressure separator system where any liquids (water, condensate, etc.) are removed. Produced oil goes through a separator to remove the natural gas from the oil.
- The gas is compressed if necessary.
- The gas is dehydrated to lower its water content.
- The gas is then metered (i.e. the amount of gas produced is measured).
- The gas is transported to a facility where it passes through a water precipitator to remove any oil.

The development "footprint" in terms of habitat loss or gravel filling has decreased in recent years as advances in drilling technology have led to smaller, more consolidated pad sizes. A single production pad and several directionally drilled wells can develop more than one and possibly several 640-acre sections (Figure 5.1). Unless pool rules (oil or gas field rules governing well drilling, casing, and spacing which are designed to maximize recovery and minimize waste) have been adopted under 20 AAC 25.520, existing spacing rules stipulate that where oil has been discovered, not more than one well may be drilled to that pool on any governmental quarter section (20 AAC 25.055(a)). This would theoretically allow a maximum of four well sites per 640-acre section. Where gas has been discovered, not more than one well per section may be drilled into the pool.

FIGURE 5.1 Drill Site Block Diagram



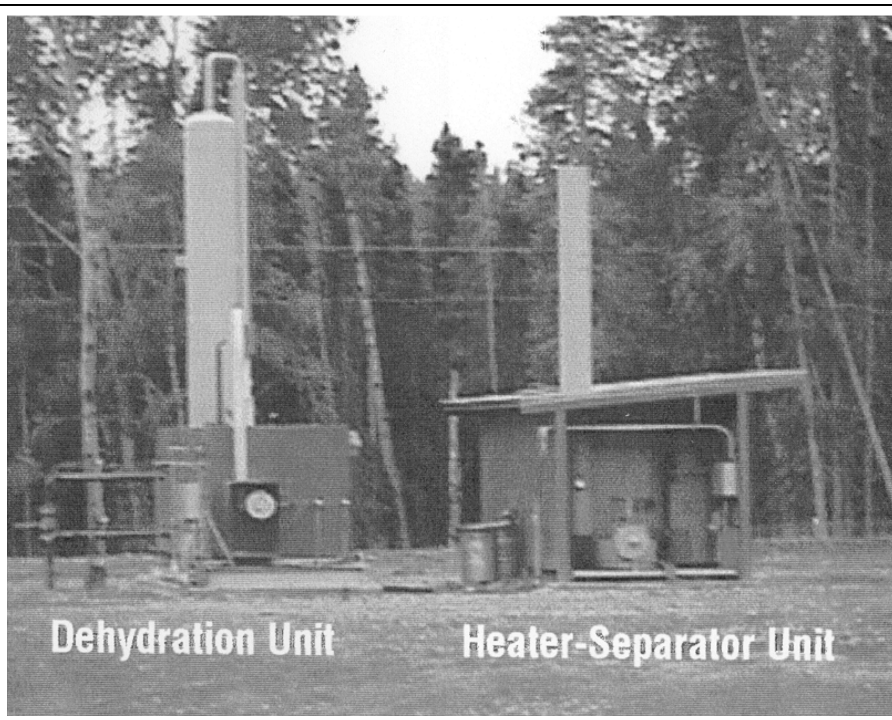
At this phase of the Nenana Basin Exploration License it is impossible to predict what a full development scenario will entail. That will depend on the surface location, size, depth and geology of a specific commercial discovery. The Wolf Lake Area Natural Gas Project, developed by Marathon Oil Company in the Kenai National Wildlife Refuge is an example of how gas fields are developed in Alaska today.

The Wolf Lake projects consist of a production facility and two gravel pads between two and four acres in size. Pads must be large enough to support drilling and production facilities. Drilling of a new well normally takes 40 to 50 days. Access to the sites is by gravel road. Pad facilities include the well, a heater separator, a methanol tank, and a liquids tank. The average thickness of fill for the gravel pad is 2 to 3 ft. In areas where underlying soils are soft or wet, geotextile fabric is used to increase stability and reduce the amount of fill required. (USFWS, 2000:19).

Natural gas, as it comes from the ground, may need to be heated to minimize the potential for the formation of natural gas hydrates. This depends on how much water is produced with the gas. As the well ages and pressure drops, more water is produced. Natural gas hydrates are a combination of water and other small molecules that produce a solid. They may plug pipelines, equipment and instruments, causing flow interruptions. After separation, methanol is added to further inhibit the formation of natural gas hydrates. Finally, a dehydration unit is used to process the gas to sales quality. Figure 5.2 shows a picture of a dehydration unit and heater-separator unit at Marathon's Sterling Production Facility in the Kenai National Wildlife Refuge (USFWS, 2000:21).

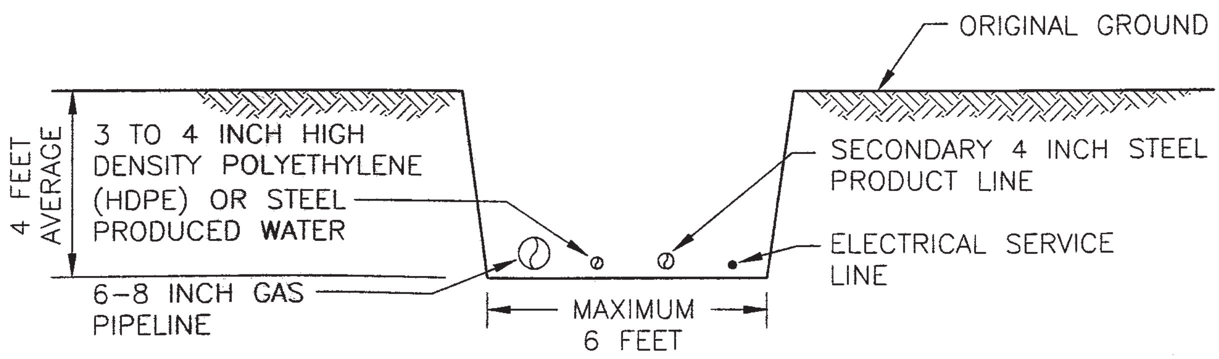
A buried 6- to 10-inch diameter steel pipeline, externally coated for corrosion protection, is used to transport the gas. A trench approximately 3 to 6 feet wide and 4 feet deep is excavated with a tracked backhoe. Excavated soil is saved and used for backfill. Disturbance in and around streams may require additional restoration efforts to eliminate the potential for sedimentation and degradation of water quality. Detailed stream crossing plan designs will be decided at the plan of operations phase.

Figure 5.2: Marathon's Sterling Production Facility on the Kenai Peninsula
Source: USF&WS 2000, Wolf Lake FEIS



Produced water is injected into an onsite underground disposal well or transported by a second 3- to 4-inch diameter pipeline to an approved offsite disposal well. If a produced water pipeline is constructed it would be buried in the same trench as the gas line. Other utility lines may also be included (Figure 5.3) (USFWS, 2000:12).

FIGURE 5.3 Typical Trench Section



Source: USF&WS, 2000. Wolf Lake FEIS.

In new wells with sufficient pressure, gas will flow through the pipeline on its own. As a well ages and pressure drops a compressor is needed to push the gas through the pipeline. Therefore, it is reasonable to conclude that a compressor will be necessary at some time in a project' s lifetime. Onsite compression facilities for Wolf Lake are expected to be in the range of 225 to 450 hp (USFWS, 2000:26). Gas flows through the pipeline as a vapor and does not have to be liquefied by cooling.

Even though the geology of the Nenana basin suggests that gas is the most likely resource that could be present in economic quantities, there still exists the remote possibility of finding commercial quantities of oil. To accommodate that possibility this chapter includes the reasonably foreseeable effects of oil production.

Oil production facilities will likely include several production wells, water injectors, gas injection wells, and a waste disposal well. Wellhead spacing on a development pad may be as little as 10 ft. A separation facility would remove water and gas from the produced crude, and pipelines would transport the crude. Some of the natural gas produced is used to power equipment on a facility, but most is re-injected to maintain reservoir pressure. Produced water is also re-injected after it is treated to remove sand and other particles.

B. Statewide Fiscal Effects

Alaska's economy depends heavily on revenues related to oil and gas production, and the government spending that results from those revenues. The following statistics illustrate various ways in which the licensing program could generate income to state government.

License Fees. The recipient of the license pays a $1.00 per acre license fee. Because this is a new program, no historical data is available on past license fee revenue at the outset.

Rentals. With exploration licensing, the state does not receive direct revenue until the licensed area is converted into oil and gas leases. Once a license is converted, each lease requires an annual rental payment of $3.00 per acre.

Royalties. Royalties represent the state's share of the production as the mineral interest owner. Royalties including bonuses provided over $788 million in revenue to the state in FY 2001 (ADOR, 2001a).

Production Taxes. Production taxes must be paid by producers on all taxable oil and gas produced from each lease or property in the state. The taxes are paid on a percentage of gross value basis. Unrestricted oil and gas production taxes were $703.1 million for FY 2001 (ADOR, 2001a).

Income taxes. All corporations in the state must pay corporate income tax for all taxable income derived from sources within the state. Special provisions apply to apportioning total income worldwide for corporations involved in producing or transporting oil and gas. Most, if not all, producers and transporters of oil and gas in Alaska are corporations. For FY 2001, oil and gas corporation taxes were $338.1 million and are expected to be $150 million in FY 2002 (ADOR 2001a).

Oil & Gas Property Taxes. An annual tax is levied each year on the full and true value of property taxable under AS 43.56. This includes exploration property, production property, and pipeline transportation property. Property Taxes amounted to $45.1 million in FY 2001.

Together these revenues comprised approximately 82 percent of the state's general fund unrestricted revenue in FY 2001. Such revenues finance the state's revenue sharing, municipal assistance, education funding, operating budget and capital budget. State spending supports nearly one out of every three jobs, and three of every ten dollars of personal income result from state spending. Nearly one of every two local government jobs (including school district jobs) in Alaska relies on state funding (ISER, 1990). Oil and gas royalties and revenues also contribute to the Alaska Permanent Fund, which pays significant dividends each year to every qualified state resident.

Oil and gas is Alaska's largest industry, spending $2.1 billion annually in the state. The industry directly spends $422 million on payroll in Alaska and $1.7 billion on goods and services in the state. Overall, this spending generates 33,600 jobs, $1.4 billion in payroll and value added to the Alaska economy of $1.8 billion, for total output of $3.1 billion. Oil and gas accounts for 12 percent of private sector jobs and 20 percent of private sector payroll. The oil and gas industry has the highest average wage in Alaska. The average producer company pays a monthly wage of $7,754, which is 2.8 times higher than the statewide average of $2,798 (McDowell, 2001:4).

Through state and local government spending of oil and gas revenues, Alaska's petroleum industry has significant indirect impacts on local communities. In 1999, $1.5 billion was spent throughout the state. This included capital projects, support of basic government operations (including payroll for state government employees) revenue sharing and municipal assistance, education funding, and Longevity Bonus Payments (McDowell, 2001:44). Furthermore, the total economic effect of any spending, including state government spending and salaries paid to private oil and gas industry employees, is always greater than the direct effect. When money is re-spent in the economy, its original value multiplies. For example, this "income multiplier" is calculated at 1.35 for state spending. This means that for every dollar of income Alaskans receive directly from state spending, an additional 35 cents of income is generated when that dollar is re-spent in the local economy (ISER, 1990).

Alaska's permanent Fund is also funded with oil and gas revenues. The Alaska Permanent Fund was established by ballot proposition in 1976. Fifty percent of all revenue generated by oil and gas activities will be placed in the permanent fund. The state's oil-wealth savings account stood at $24.7 billion on November 30, 2001. All qualified Alaskans who apply, receive an annual dividend from the earnings of the permanent fund. In 2001, approximately $1.09 billion was distributed under the program to approximately 590,423 eligible Alaskans. Every qualified man, woman, and child in Alaska received a dividend check of about

$1,850. The dividend is calculated using a five-year average of Permanent Fund investment income. The PFD is an equitable benefit transfer because it reaches every individual regardless of income or socio-economic status.

Figure 5.4: Historic Alaska Petroleum Revenue

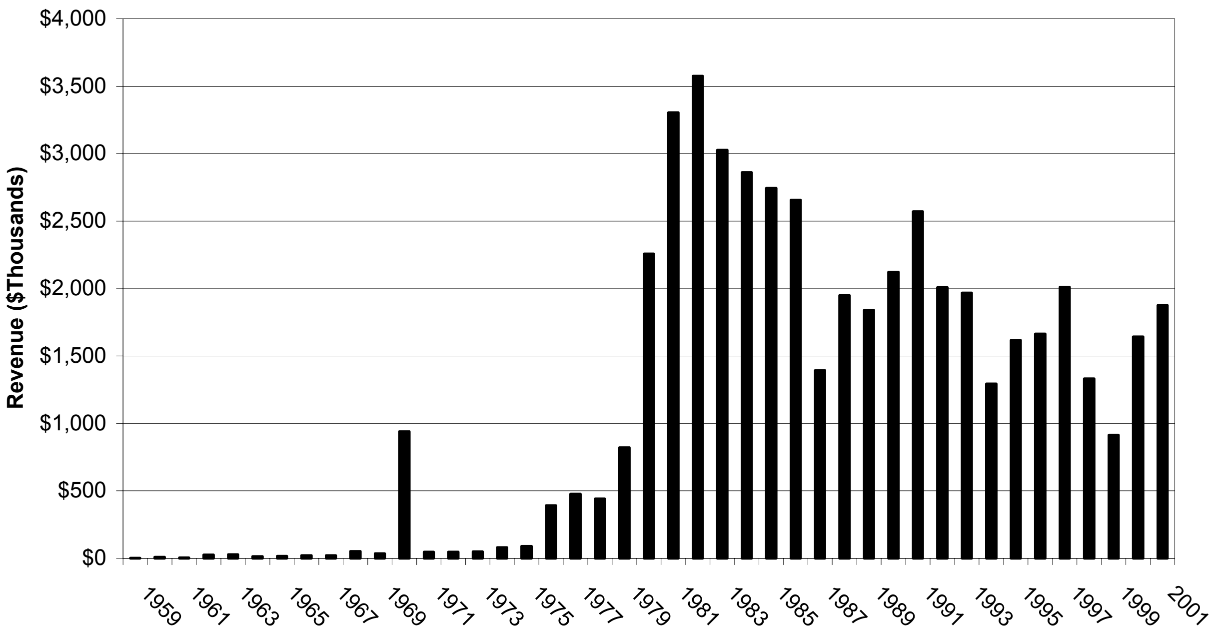
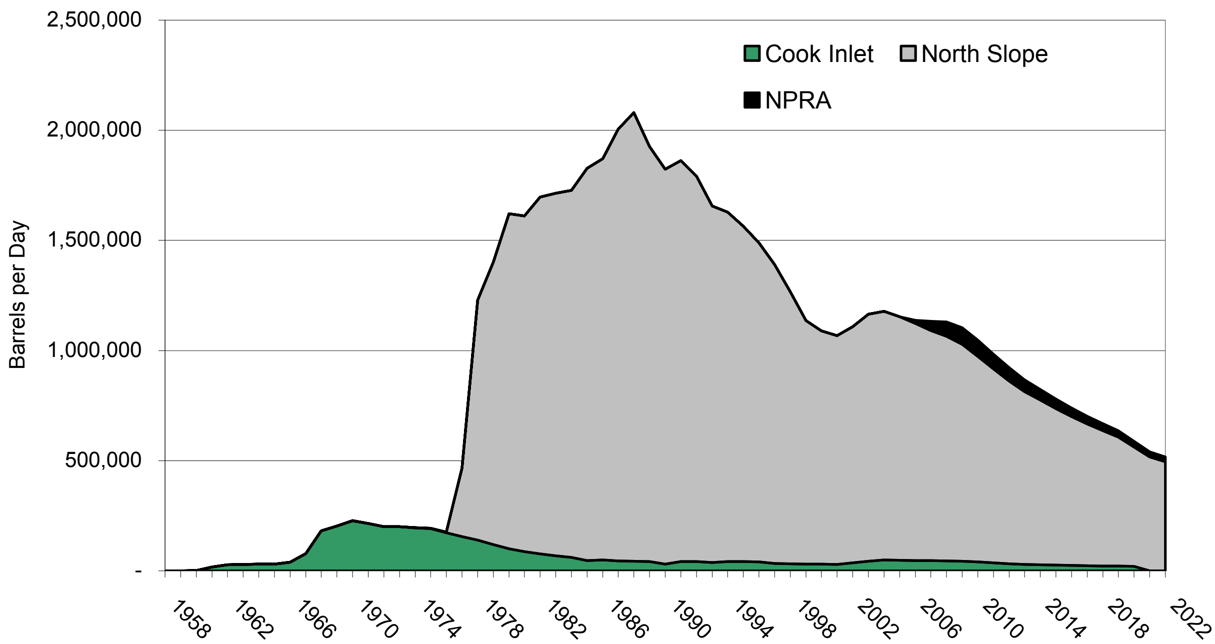
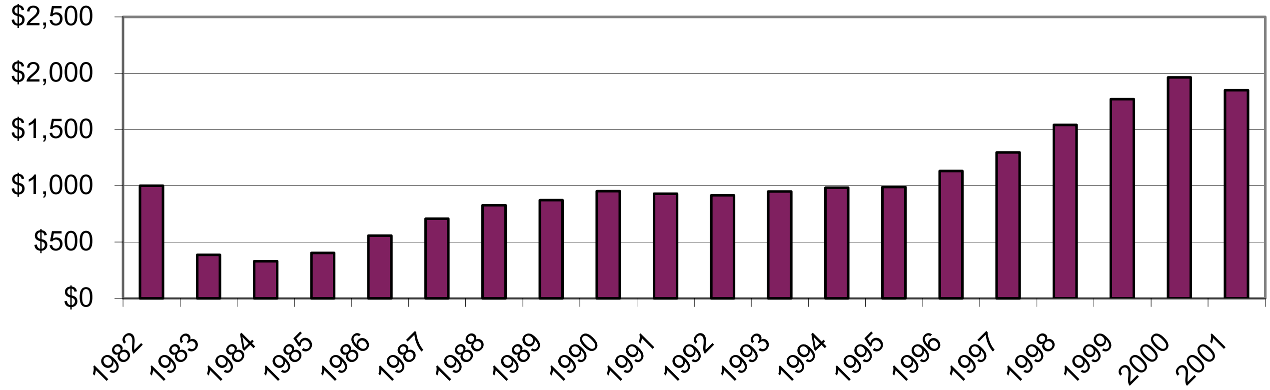


Figure 5.5: Historic and Projected Alaska Oil Production



Source: ADNR, 2002

Figure 5.6: Alaska Permanent Fund Dividends (1982-2001)



The Permanent Fund dividend, projected to pump in excess of $1 billion into the hands of Alaskan consumers annually, has contributed to growth of the economy like any other basic industry. Its influence will decline in future years as a portion of the earnings of the Permanent Fund, including part of the share now allocated to the dividend, is appropriated to cover the necessary expenses of state government (ISER, 2001).

C. Effects on Municipalities and Communities

Portions of the study area are within the Denali Borough and the Fairbanks North Star Borough, but the greatest portion of the study area is not located within a borough. The Denali Borough encompasses an area of 12,775 mi^2 and has a population of 1,893. It lies about 110 miles south of Fairbanks on the Parks Highway. Seventy percent of the Borough is the Denali National Park, (ADCED, 2001). The Denali Borough has no property or sales tax; it derives it's revenue from a 7 percent accommodation tax and a $.05/Yard severance tax. The Usibelli Coal Mine, Clear Air Force Station, Golden Valley Electric Assoc., the Borough School District, the National Park Service, and tourism-related industries and road services provide the majority of employment in the Denali Borough.

The Fairbanks North Star Borough encompasses 7,444 mi^2. With a population of 82,840, it is the second-largest population center in the state. The Borough levies a property tax (16.849 mills) and an 8 percent accommodation tax. There is no sales tax. City, borough, state and federal government agencies, including the military, provide nearly half of the employment in the Borough. Eielson Air Force Base, the Borough School District and the University of Alaska Fairbanks are the primary public employers. Retail services, tourism, transportation, medical, and other services are the primary private sector activities.

Local communities in or near the study area are Nenana, Minto, and Anderson. Anderson is within the Denali Borough. Nenana and Minto are in unincorporated areas. Oil and gas activities may cause changes to the quality of peoples' lives. These indicators include household or per capita income, occupancy or rental rates, or population density. However, intervening factors, such as overall population growth in the area, make it impossible to measure or predict such changes.

1. Employment

Exploration licensing in the Nenana Basin may stimulate new employment at the local level in the oil and gas industry. Additional jobs may be created in the mining, construction, transportation, and retail industries. Increased employment and income may also stimulate increases in the finance, insurance, real estate and government. Local businesses, such as charter operators, parts distributors, heavy equipment operators, welders, plumbers and pipe fitters, carpenters, vendors, food service providers, and air carriers could provide support for oil and gas activities. Short-term job opportunities could arise during the exploration phase. The long-term employment benefits of a license on local communities will depend on the subsequent production of commercial quantities of petroleum.

Table 5.3 Fairbanks North Star Borough Average Monthly Employment and Earnings, 1999

Industry	Workers	Earnings
Mining (includes oil and gas)	821	$5,411
Construction	1,775	$3,700
Trans/Comm/Utilities	3,070	$3,399
Trade	6,586	$1,696
Finance, Insurance, Real Estate	1,085	$2,641
Federal Government	3,277	$3,264
State Government	4,350	$2,769
Local Government	2,736	$2,931
Source: Alaska Department of Labor, 1999		

Table 5.4 Denali Borough Average Monthly Employment and Earnings, 1999

Industry	Workers	Earnings
Mining	134	Not available
Construction	23	Not available
Trans/Comm/Utilities	399	$2,680
Trade	642	Not available
Finance, Insurance, Real Estate	6	Not available
Federal Government	187	$3,686
State Government	16	$4,775
Local Government	109	$2,112
Source: Alaska Department of Labor, 1999		

An influx of workers from outside Alaska as a result of an exploration license in this area is unlikely. As existing Alaska fields decline, more and more of the current resident labor pool and service support industry will be in need of employment. Under Mitigation Measure 12, licensees are encouraged to hire local residents and contractors to the extent they are available and qualified. Licensees shall submit, as part of the plan of operations, a proposal detailing the means by which the licensee will comply with the measure. The proposal must include a description of the operator's plans for partnering with local communities to recruit and hire local and Alaska residents and contractors. The licensee is encouraged, in formulating this proposal, to coordinate with employment services offered by the state of Alaska and local communities and to recruit employees from local communities. The long-term benefits of this license will depend on subsequent production of commercial quantities of natural gas or oil. It is not possible to predict the number of jobs that may be created until discoveries are made.

2. Public Services

New exploration and development activities might require labor and capital-intensive infrastructure. The presence of workers may increase the demand for some public services, like housing or sanitation. New exploration and development projects undertaken in areas away from existing infrastructure would have to be self-sufficient operations. If located near existing communities, such activities might place additional burdens on nearby community facilities. Since the existence of new developments is unknown at this time, it is not possible to predict the impact on community services.

Some oil and gas projects may require a source of electricity or water. A licensee may provide their own water or electricity or may utilize those of a local community. The suitability of an existing community utility would depend on the specific project proposed, its location, and the existing supply and demand for the service. It would also depend on the ownership structure of the utility and whether the facility had the capacity to accommodate industrial demand. New development may require a new or expanded utility.

3. Energy Costs

A substantial natural gas discovery may be very beneficial to residents living in the interior by providing a cleaner, lower cost fuel for heating and power generation. Currently fuel oil and electricity are the predominant energy source for residential space and water heating in interior communities. According to the Alaska Natural Gas Instate Demand Study, there is an approximate 20 percent discount by moving from fuel oil to natural gas and a 27 percent discount by moving from electricity to natural gas. Total annual savings would be approximately $275 for interior households switching from fuel oil to natural gas (see Table 5.5). ADNR regards these estimates as conservative. There may also be fuel switching opportunities for power plants in the Interior region. The advantages of this include generating electricity with a more efficient, state of the art natural gas powered facility (Dismukes, 2002).

Table 5.6 shows that monthly customer charge for natural gas is approximately 78% higher in Fairbanks than in Southcentral Alaska. Fairbanks Natural Gas (FNG) purchases liquefied natural gas and transports it to Fairbanks by truck. It serves approximately 400 customers. In order for gas from the Nenana basin to be commercially viable it will have to cost less to deliver than the current available fuels in Interior Alaska. Currently, FNG's cost for natural gas delivered to a home is $8.00 per 100 cubic feet (ccu). Anchorage residents pay $4.50/ccu. The cost of fuel oil in Fairbanks is $8.86 per 1000 btu ($1.17/gallon).

Table 5.5: Estimated Total Bills for Residential Space and Water Heating by Fuel Type

Interior Region	Average Annual MMBtu per Household	Fuel Oil Cost Per Household	Electricity Cost Per Household	Natural Gas Cost Per Household
Space Heating	158.01	$1,149	$1,222	$928
Water Heating	39.20	$285	$303	$230
Total	197.21	$1,434	$1,525	$1,159
Source: Dismukes, 2002				

Table 5.6: Average Monthly Use and Cost by Enstar and Fairbanks Natural Gas Customers

Utility	Average Monthly Usage	Monthly Rate per 100 Cubic Feet	Monthly Customer Charge	Average Monthly Billing
Enstar Natural Gas[2]	175	0.39757	$4.50	$74.13
Fairbanks Natural Gas[3]	138	0.75900	$8.00	$112.82
[1]As of June 30, 2001 [2]Enstar Natural Gas serves the following areas: Anchorage, Big Lake, Bird Creek, Chugiak-Eagle River, Eklutna, Girdwood, Houston, Indian, Kenai, Knik, Nikiski, Palmer, Peters Creek, Portage, Sterling, Soldotna, Wasilla, and Whittier [3]Fairbanks Natural Gas serves the Fairbanks Area.				
Source: Regulatory Commission of Alaska, June 30, 2001				

The Village of Minto uses diesel fuel to generate electricity. In 2001 the Alaska Village Electric Cooperative Inc. (AVEC) used 156,000 gallons of diesel to provide electricity at a rate of 44¢ cents per kilowatt hour (kwh). Under the Power Cost Equalization (PCE) program the state pays a subsidy for the first 500 kwh used per month per customer. The PCE subsidy for Minto is 23.61¢ per kwh, resulting in cost to the consumer of 20¢ per kwh. In comparison, Anchorage residents pay 9¢ and Fairbanks residents pay 11¢ per kwh with no PCE subsidy. Additionally in 2001, the Village of Minto used 122,000 gallons of fuel oil for residential space heating at a cost of $1.53 per gallon (RCA, 2002; AVEC, 2002).

4. Land Use

Under Mitigation Measure 3, exploration activities must be supported only by ice roads, existing road or trail systems, or air or boat service. The use of winter roads may also be allowed. A winter road is compacted/bladed snow with vegetative clearing to provide a level running surface and has a load bearing capacity derived from a combination of frost, snow, or ice. The road is not normally watered to produce an iced running surface. Many winter roads have been constructed in portions of the study area for logging operations. Exceptions, including the use of gravel, may be granted by the Director on a site-specific basis, if it is determined, after consulting with ADF&G that no feasible or prudent alternative exists.

Development of the area could adversely affect human uses of the area and its biological resources if access to hunting, fishing, or trapping areas is restricted or if industry activities occur at the same place and time as these activities. Use of the area by the public will be unrestricted, except when required for protection of facilities and structures, or for public safety.

It is also possible that a proposed activity (especially the building of additional permanent roads) could allow for easier access to private property. The resultant increase in human presence on these lands could have negative impacts on traditional and recreational use. Conversely, development of the area could actually increase public access for users of the area's resources. If roads or other permanent access routes were constructed or developed across general state lands, they would be open to the public and available for multiple use activities. If development occurs, consolidation of petroleum facilities would reduce conflicts with recreation uses of the area. Consolidation benefits both the public and industry. The "visual, environmental, social, and economic effects are concentrated," and projects are "less complicated and less costly" (ADCRA 1978:31).

D. Cumulative Effects

The potential negative impacts of industry's activities in the study area include potential loss of fish and wildlife habitat; environmental degradation; and restriction of access for subsistence uses, fishing and hunting. Potential positive effects include increased understanding of the environment, protection of existing habitat and wildlife values, habitat restoration and enhancement, and infrastructure to support continued use of local resources.

1. Effects on Water, Air, and Land Resources

a. Effects on Water Quality

Water quality throughout the study area is generally good. Ponds and lake habitats tend to be high in mineral and organic nutrients that promote a proliferation of plant life, especially algae, which reduces the dissolved oxygen content and often causes the extinction of other organisms. However, near constant daylight during the summer limits daily oxygen depletion in these waterbodies, and allows them to be used by various species of fish (ADF&G, 1992:A-8).

Water quality varies seasonally with changes associated with streamflow. Mean annual peak runoff occurs during and after breakup and elevated turbidity and suspended sediment levels are common during these months. Natural as well as man-made inputs can result in exceedences of water quality criteria. Natural inputs to fresh water supplies include dead fish, birds, and animals; mosquito and insect larvae; algae and other plants; bacteria; parasites such as Giardia; silt and glacial flour; arsenic, iron, manganese; and hydrogen sulfide gas (AEIDC, 1975).

Water quality characteristics which may be altered by oil and gas activities include pH, total suspended solids, organic matter, calcium, magnesium, sodium, iron, nitrates, chlorine, and fluoride. Potential impacts which may alter surface water quality parameters of the study area include accidental spills of fuel, lubricants or chemicals; increases in erosion and sedimentation causing elevated turbidity and suspended solids concentrations; and oil spills.

Geophysical exploration of the study area is not expected to alter water quality because seismic surveys are conducted in winter and permit conditions mitigate potential damage. Under standard ADNR permit conditions for winter seismic exploration, the use of ground-contact vehicles for off-road travel is limited to areas where adequate ground frost and snow cover prevent damage to the ground surface. Equipment, other than vessels, must not enter open water areas of a watercourse during winter, and any ice roads, ice bridges, or approach ramps constructed near river, slough, or stream crossings must be free of extraneous material before break-up. Alterations of the banks of a watercourse are prohibited (ADGC, 1995). Adherence to these conditions thus avoids or minimizes post-seismic increases in erosion, turbidity, and suspended solids in a drainage area.

The extent and duration of water quality degradation resulting from accidental spills depends on the type of product; the location of the spill; volume; season and duration of the spill or leak; and the effectiveness of clean-up response. Heavy equipment, such as trucks, tracked vehicles, aircraft, and tank trucks commonly use diesel fuel, gasoline, jet fuel, motor oil, hydraulic fluid, antifreeze, and other lubricants. Spills or leaks could result from accidents, such as during refueling, or from corrosion of lines (Parametrix, 1996). Under standard ADNR permit conditions for off-road activity, fuel and hazardous substances must have secondary containment apparatus. A secondary containment or surface liner must be placed under all container or vehicle fuel tank inlet and outlet points. Appropriate spill response equipment must be on hand during any transfer or handling of fuel or hazardous substances. Vehicle refueling is prohibited within annual floodplains (ADGC, 1995). Impacts of oil spills are discussed in Chapter Six.

Other standard ADNR land use permit conditions serve to protect water quality values from facility construction and operation. Trails, campsites and work areas must be kept clean. Trash, survey markers, and other debris that may accumulate in camps or along seismic lines and travel routes that are not recovered during the initial cleanup must be picked up and properly disposed of. All solid wastes, including incinerator residue must be backhauled to a solid waste disposal site approved by ADEC. Vehicle maintenance, campsites, and the storage or stockpiling of material on the surface of lakes, ponds, or rivers are prohibited (ADGC, 1995).

The federal Clean Water Act established the National Pollutant Discharge Elimination System (NPDES) to permit discharges of pollutants into U.S. waters by "point sources," such as industrial and municipal facilities. In Alaska, the U.S. Environmental Protection Agency issues NPDES permits, designed to maximize treatment and minimize harmful effects of discharges as water quality and technology improvements are made. ADEC certifies that these discharge permits will not violate the state's water quality standards.

ADEC issues industrial and municipal wastewater permits, and monitors wastewater discharges and the water quality of waterbodies receiving the discharges. ADEC certifies federal wastewater permits with mixing zones that allow industrial and municipal facilities to meet state water quality standards. Industrial and municipal wastewater facilities are inspected annually. ADEC also certifies U.S. Army Corps of Engineer dredge and fill permits in wetlands and navigable waters to ensure compliance with state water quality standards, and provides technical assistance for design, installation, and operation of industrial and municipal wastewater systems.

Mitigation Measures

The following are summaries of some applicable mitigation measures designed to mitigate potential impacts to water quality. For a complete listing of mitigation measures and licensee advisories see Chapter Seven. Additional, site-specific and project-specific mitigation measures may be imposed as necessary if exploration and development take place.

- Vegetation protection – Winter and summer off-road vehicular traffic is restricted and must be approved in plan of operations.
- Wetland and Riparian Protection – Licensees must avoid siting facilities in key wetlands and identified sensitive habitat areas. Facilities other than docks, or road and pipeline crossings, will not be sited within 500 ft. of fishbearing waterbodies. Permanent facility siting is prohibited within ¼-mile of the banks of major rivers.
- Water Conservation – Removal of water from fishbearing rivers, streams, and natural lakes shall be subject to prior written approval by DMLW and ADF&G.
- Turbidity Reduction – Gravel mining sites will be restricted to the minimum necessary to develop the field efficiently and with minimal environmental damage and must not be located within an active floodplain of a watercourse.
- Drilling Waste – Underground injection of drilling muds and cuttings is preferred method of disposal. For onshore development, produced waters must be injected. Surface discharge of drilling wastes into waterbodies and wetlands is prohibited. Discharge of produced waters in marine waters less than 10 m deep is prohibited. Unless authorized by NPDES or state permit, disposal of wastewater into freshwater bodies, including Class III, IV, VI, and VIII wetlands, is prohibited.

- Oil Spill Prevention and Control – Licensees are required to prepare contingency plans addressing prevention, detection, and cleanup of oil spills. Pipelines must be designed and located to facilitate cleanup. Buffer zones of not less than 500 ft. will be required to separate onshore oil storage facilities (with a capacity greater than 660 gallons) and sewage ponds from freshwater supplies, streams, and lakes and key wetlands

b. Effects on air quality

Air quality throughout the study area is assumed to be excellent with concentrations of regulated pollutants well below the maximum allowed under National Ambient Air Quality Standards. Industrial operations are limited and there are no metropolitan centers in the area. It is assumed the only pollutant sources are fugitive dust from travel on gravel roads, forest fires and localized smoke from cabins (BLM, 1989:3-1).

Routine activities associated with oil and gas exploration, development and production that are likely to affect air quality are emissions from construction, drilling and production. Air pollutants include nitrogen oxides, carbon monoxide, sulfur dioxide, particulate matter, and volatile organic compounds[1] (MMS, 1995, IV.B.1-92). Effects from VOC emissions would be insignificant because of the low potential for ozone formation. Photochemical pollutants such as ozone form in the air from the interaction of pollutants in the presence of sunshine and heat. In the upper atmosphere ozone is beneficial because it absorbs solar ultraviolet radiation. In the lower atmosphere however, it is a strong oxidizing agent and can be harmful. There is a low potential for ozone formation in the study area because the summertime air temperatures remain relatively low (MMS, 1996a, IV.B.1-94).

Trucks, heavy construction equipment and earth moving equipment would produce emissions, such as engine exhaust and dust. Sources of air emissions during drilling operations include rig engines, camp generator engines, steam generators, waste oil burners, hot-air heaters, incinerators, and well test flaring equipment. Emissions would also be generated during installation of pipelines and utility lines, excavation and transportation of gravel, mobilization and demobilization of drill rigs, and during construction of gravel pads, roads, and support facilities. Elevated levels of airborne emissions would be temporary and would diminish after construction phases are complete. Emissions would also be produced by engines or turbines used to provide power for drilling, oil pumping, and water injection. In addition, aircraft, supply boats, personnel carriers, mobile support modules, as well as intermittent operations such as mud degassing and well testing would produce emissions (MMS, 1996a, IV.B.1-93).

Other sources of air pollution include evaporative losses (VOC) from oil/water separators, pump and compressor seals, valves and storage tanks. Venting and flaring could be an intermittent source of VOC and sulfur dioxide (MMS, 1995, IV.B.1-93). Gas blowouts, evaporation of spilled oil and burning of spilled oil may also affect air quality. Gas or oil blowouts may catch fire. A light, short-term coating of soot over a localized area could result from oil fires. However, soot produced from burning oil spills tends to slump and wash off vegetation in subsequent rains, limiting any health effects (MMS, 1995a, IV.B.1-95).

The Tanana Valley, which is hemmed in by mountains and hills on all sides but the southwest, has some of the world's strongest temperature inversions (Rozel, 1995). Very strong and persistent inversions can develop at high northern latitudes because of long winter nights and weak daytime sunlight. A temperature inversion occurs when cold air near the ground is overlain by warm air above (DHHS, 1997). Cold air is

[1] Volatile organic compounds are any hydrocarbon that can become a vapor at room temperature.

heavier than warm air and once an inversion forms, the air is very stable. Mixing that would normally occur by the rising of warm air is inhibited. Consequently pollutants such as carbon monoxide, sulfur compounds and ice fog remain trapped near the ground (Davis, 1976).

ADEC's Air Quality Maintenance program controls significant, stationary sources of air contaminants to protect and enhance air quality and abate impacts on public health and the environment. The 1970 Clean Air Act established air quality programs to regulate air emissions from stationary, mobile and other sources, which pose a risk to human health and the environment. ADEC monitors compliance with regulations and air quality standards through annual inspections and uniform enforcement procedures. The agency issues operating permits to existing major facilities incorporating all applicable requirements, and issues construction permits to new large facilities and for expansions of existing facilities. In order to ensure that air quality standards are maintained, additional limitations on nitrogen dioxide, sulfur dioxide, and total-suspended-particulate matter are imposed on industrial sources under the provisions of the Prevention of Significant Deterioration Program, administered by EPA.

It is not possible to predict at the licensing stage the amount of pollutants that may be produced. All industrial emissions must comply with the Clean Air Act (42 U.S.C. §§ 7401-7642) and state air quality standards. 18 AAC 50 provides for air quality control including permit requirements, permit review criteria, and regulation compliance criteria. 18 AAC 50.300 sets up standards for air quality at certain facilities, including oil and gas facilities, at the time of construction, operation, or modification. Federal and state statutes and regulations that will mitigate potential impacts to air quality include:

- 42 U.S.C. §§ 7401-7671. Federal Clean Air Act
- AS 46.03. Provides for environmental conservation including water and air pollution control, radiation and hazardous waste protection.
- 18 AAC 50. Provides for air quality control including permit requirements, permit review criteria, and regulation compliance criteria.
- 18 AAC 50.300. Sets up standards for air quality at certain facilities including oil and gas facilities at the time of construction, operation, or modification.

c. Effects on land habitat

Exploration and development activities within the study area are likely to involve some clearing and grubbing of vegetation, especially in upland portions. Clearing involves chipping the vegetation or felling and removing trees and undergrowth from an area. Grubbing involves removal of roots and other vegetation within the same area. The Director of DO&G must approve any clearing and grubbing for exploration or development. Disturbed areas would likely be re-vegetated following construction, or allowed to regenerate naturally. However, slash resulting from clearing and grubbing of vegetation must be disposed of in an appropriate manner to reduce the risks of infestation and disease.

Wetlands are the nursery grounds, staging areas, and filtration systems for much of the wildlife and river systems. Wetland areas provide the regulation and modulation of surface water helping to prevent erosion of water bodies. Degradation or isolation of wetland areas may detrimentally affect the entire water body system and organisms involved (Rappoport, 2000). Although every effort will be made to avoid impacting wetlands during exploration and development within the study area, it may become necessary to develop some wetlands. The discharge of dredge or fill material affecting wetlands requires a Section 404 permit from the U.S. Army Corps of Engineers and, depending on the activity, may also require additional action from the U.S. Environmental Protection Agency, State Division of Governmental Coordination, and ADEC.

Seismic surveys. Seismic surveys are usually conducted in winter to minimize impacts to the environment, fish and wildlife and their habitats, and on people. In the past, surveyors required long clear-cuts for line-of-sight measurements. That practice left distinct lines, which crisscrossed the forest. Modern seismic surveys use global satellite positioning instruments and line-of-sight clearing is no longer necessary. Most areas are accessible by helicopter, which, if using explosives as an energy source, lowers a portable drill to the ground (Clulow, 2002). A hole is drilled and an explosive charge placed. Only the soil in the immediate vicinity of the explosive charges is disturbed. To avoid undesirable effects on shallow wells and nearby building foundations, hydraulic devices are used in lieu of explosives to produce the seismic wave energy.

Drilling and Production Discharges. During exploration well drilling, muds and cuttings are stored on-pad, in holding tanks, or in a temporary reserve pit, and then hauled to an approved solid waste disposal site or reinjected into the subsurface at an approved injection well.

Effects of Construction and Gravel Infilling. Effects of constructing production pads, roads, and pipelines include direct loss of acreage due to gravel infilling, and due to impoundment and diversion of water. A secondary effect of construction activities includes dust deposition, which may reduce photosynthesis and plant growth, and downstream siltation and sedimentation, which can affect plant viability. Road construction, vehicular passage, and oil spills can alter surface albedo (reflectivity of sunlight off the earth's surface) or water drainage patterns, resulting in thaw and subsidence or inundation. Such changes can affect regeneration and revegetation of certain species, and species composition may also change after disturbance from construction activities (Linkins, et al., 1984).

After an oil field is abandoned, some level of land rehabilitation will be required to restore areas impacted by oil and gas activities. Recovery of wetlands disturbed by gravel infilling varies depending on soil moisture content and amount of available soil organic matter (Kidd, et al., 1997, citing to Jorgenson and Joyce, 1994). Removal of gravel from pads and roads is the initial step in rehabilitation. One method preferred by ADF&G is to remove all gravel and create pond habitat that resembles pre-construction conditions. In some cases, full gravel removal may not be the optimum recovery option. In most cases, plant cultivation is desirable with the use of plant species identified as important for waterbird or moose habitat. While rehabilitation methods for gravel pad and roads vary depending on site-specific conditions, the overall goal of rehabilitation in the existing oil and gas fields is to replace native vegetation. Plant cultivation treatments include fertilizer only, native-grass cultivation, and transplantation of desired species. Optimum recovery of the land habitat would include reestablishing vegetable, soil microbiotic, phytoplankton, aquatic invertebrate, and wildlife communities at the impacted site (Kidd, et al., 1997).

Gas Blowouts. If a natural gas blowout occurred, plants in the immediate vicinity may be destroyed. Natural gas and condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations. Insects, such as mosquitoes would also be affected or killed by a gas blowout. A plume of natural gas vapors and condensates would be dispersed very rapidly from the blowout site, but is not expected to be hazardous for more than one kilometer downwind or for more than one day. Natural gas development is expected to have little to no effect on lower trophic-level organisms (MMS, 1996b: IV-L-2).

Oil Spills. Spilled oil will affect vegetation depending on time of year, type of vegetation, and terrain. Spilled oil will migrate both horizontally and vertically. This flow depends on factors including the volume spilled, type of cover (plant or snow), slope, presence of cracks or troughs, moisture content of soil, temperature, wind direction and velocity, thickness of the oil, discharge point, and ability of the ground to absorb the oil (Linkins, et al., 1984). The spread of oil is less when it is thicker, cooler, or is exposed to chemical weathering. If the ground temperature is less than the pour point of the oil, it will pool and be easier to contain. Dry soils have greater porosity and the potential for vertical movement is greater (Linkins, et al., 1984, citing to Everett, 1978). If oil penetrates the soil layers and remains in the plant root zone, longer-term effects, such as mortality or reduced regeneration would occur in following summers. Under the right conditions involving oxygen, temperature, moisture in the soil, and the composition of the crude being spilled, bacteria assist in the breakdown of hydrocarbons in soils. Petroleum-contaminated soils are commonly treated with fertilization, raking, and tilling (bioremediation) or with heat (thermal desorption). Thermal desorption entails heating contaminated material at temperatures between 600º and 1000°F. Research is ongoing in the use of microbes to assist the natural breakdown of petroleum in soils and gravel (Linkins, et al., 1984) (AJC, 1996).

Mitigation Measures

The following are summaries of some applicable mitigation measures designed to mitigate potential impacts to land and habitat. For a complete listing of mitigation measures and licensee advisories see Chapter Seven. Additional, site-specific and project-specific mitigation measures may be imposed as necessary if exploration and development take place.

- Wetland protection – Licensees must avoid siting facilities in key wetlands and identified sensitive habitat areas.
- Habitat loss minimization – Exploration facilities must be temporary. Ice roads and pads are preferred structures. Gravel mining is restricted to the minimum necessary to develop the field efficiently.
- Drilling waste – Underground injection of drilling muds and cuttings is preferred method of disposal. For onshore development, produced waters must be injected. Surface discharge of drilling wastes into waterbodies and wetlands is prohibited. Discharge of produced waters into open or ice-covered marine waters of less than 10 m in depth is prohibited.
- Oil Spill Prevention and Control – Licensees are advised they must prepare contingency plans addressing prevention, detection, and cleanup of oil spills. Pipelines must be designed and located to facilitate cleanup.

d. Effects on Fish and Fisheries

All water bodies that provide anadromous fish habitat also provide resident fish habitat. In addition, several areas within the study area provide high quality habitat for resident fish only. The Tolovana River and lower Minto Flats provide spawning, rearing, and limited overwintering habitat for northern pike, while the Chatanika River, upper Minto Flats, and lower Goldstream Creek are important for pike spawning, rearing, and overwintering (ADF&G, 2001). Use patterns vary by species and within species by life stage. Potential impacts are discussed below.

Noise and Disturbance: Activities associated with laying a pipeline would have localized effects on fish. Disturbances during construction would probably displace fish a short distance, but they would reutilize the habitat upon completion of activities (MMS, 1996b: IV.L.2).

Habitat Loss: Most exploration activity occurs during the winter months to minimize damage to the environment. The construction of ice roads and clearing of vegetation during ice road or pipeline construction would involve use of heavy equipment and, in areas where equipment must cross streams, degradation of the steam banks could occur. Damage to stream banks could lead to erosion the following season, which could affect adjacent fish habitat through siltation of the streambeds. During the open water period, protecting the integrity of stream bank vegetation and minimizing erosion are important elements in preserving fish habitat. To maintain fish habitat and populations within the study area, the use of heavy equipment within riparian habitat will be prohibited and bridges or non-bottom-founded structures will be required for crossing streams.

Withdrawal of water from lakes and ponds for ice road construction could affect fish overwintering habitat by entraining juvenile fish, lowering water levels, and increased disturbance. The construction of ice roads across rivers and streams may also affect the ability of fish to reach overwintering areas by blocking movement under the ice and causing direct loss of overwintering habitat. Blockage of movement could also occur from improper installation of culverts in streams for permanent roads. Mitigation measures to protect fish and overwintering areas from damage due to ice road construction include: obtaining written permission from ADF&G before removing water from fish-bearing waterbodies, limiting flow of and screening water intake pipes from fish-bearing waterbodies to prevent fish entrapment, and prohibiting compaction or removal of snow over fish-bearing streams.

During oil and gas related development, gravel removal from fish-bearing streams to support oil and gas activities could adversely impact the habitat in these streams and the fish they support. Gravel removal could increase sediment loads, change the streambed course, cause instability upstream, destroy spawning habitat, and create obstacles to fish migration. To prevent harm to fish habitat, gravel mining within an active floodplain will be prohibited under the mitigation measures.

Seismic Activities: Seismic activities are typically conducted during the winter months to minimize the effect on the environment. Seismic operations using explosives could cause direct injury to fish resources in lakes and streams (Fink, 1996). Pressure waves from explosives can potentially kill and injure fish near the explosion but the impulses would dissipate to a non-lethal level within a short distance (less than 328 ft.) (MMS, 1996b). Overpressures of 30 to 40 pounds per square inch (psi) will kill fish with swim bladders, and 3 to 4 psi can kill juvenile salmonids. Shock waves from explosions can also shock and jar fish eggs at sensitive stages of development. These types of impacts are mitigated by restricting the use of explosives in close proximity to fish-bearing lakes and streams. Mitigation measures to protect fish eggs may include limiting the timing of seismic work and are considered by DO&G on a case-by-case basis as a condition for obtaining a geophysical exploration permit. Other restrictions include requiring that seismic activities be set back far enough from freshwater fish spawning areas that shock waves are reduced to safe levels before reaching incubating eggs during sensitive stages of development (Fink, 1996).

Gas Blowouts: In the event of a natural gas explosion and fire, some fish in the immediate vicinity could be killed. Blowouts of natural gas condensates that did not burn would be dispersed very rapidly at the blowout site thus, it is not likely that toxic fumes would affect fish or their food sources except those very near to the source of the blowout (MMS, 1996b: IV.L.2).

Oil Spils: Oil spills within the study area could range from small, chronic leaks from equipment or facilities to catastrophic pipeline failures or drilling blowouts. The effects of oil spills on fish in the study area would depend on many factors, including the time of year, size of the spill, and the waterbody affected. Potential adverse effects from an oil spill could include direct mortality from oiling of the gills, mortality of prey species, mortality from consumption of contaminated prey, and blockage of movement or displacement from important habitats. Mortality of egg and larva could occur in spawning or nursery areas from the toxic effects of the oil. Sub-lethal effects may also reduce fitness and affect the ability to endure environmental stress. Effects of oil spills during the winter would be expected to be negligible, but could potentially be major during the open water season, depending on the site-specific conditions. Mitigation measures to protect fish and eggs from an oil spill include: siting facilities away from fish-bearing streams and lakes, development of oil spill contingency plans, and providing adequate spill response training.

If fish resources are reduced or damaged by any cause (natural or as a result of human activity), the ADF&G commissioner (through delegated emergency order authority) or the Alaska Board of Fisheries may take conservation actions that will reduce the opportunity to take fish. Restrictions on the sport fishery will degrade the angling opportunity, quality of life, and social and economic benefits described in the Sport Fishing section of Chapter Four. If access is restricted, opportunity to use sport fisheries resources in restricted areas may be reduced. Such a reduction, in addition to the direct effect of fewer fish available, may cause angler effort to shift to other fish stocks. Such a shift will result in reduced diversity of angling opportunity, and may increase pressure on the remaining fish stocks to a level dictating added restrictions on those sport fisheries, with degradation as above. Significant, unplanned increases in access could have the same ultimate result, as competition increases for finite fishing opportunity. Effects on human use of the fish resources could occur both within the study area and outside of it since some fish stocks using the study area are part of sport fisheries outside the area.

Mitigation Measures

The following are summaries of some applicable mitigation measures designed to mitigate potential impacts to fish. For a complete listing of mitigation measures and licensee advisories see Chapter Seven. Additional, site-specific and project-specific mitigation measures may be imposed as necessary if exploration and development take place.

- Protection From Drilling and Production Discharges – Licensees must use appropriate methods for disposal of muds, cuttings, and produced waters.
- Protection of Fish Habitat, Including Fish Overwintering Areas – Licensees must avoid altering stream banks and obtain approval for the location of fish stream crossings. Licensees might be required to construct ice or snow bridges if ice thickness at a crossing is insufficient to protect the streambed and the stream bank, or to incorporate construction techniques that prevent associated freeze-down from blocking fish passage. Licensees must not operate equipment (except boats) in open water areas of rivers and streams. When a fish-bearing waterbody is used as a water source, Licensees must use appropriate measures to avoid entrainment of fish. Permanent facilities must be sited away from fish-bearing streams and lakes.
- Protection From Seismic Activities – Licensees must follow requirements for explosives during onshore seismic activities, and are prohibited from using explosives in open water areas of fish-bearing streams and lakes.
- Oil Spill Prevention and Control – Licensees must prepare contingency plans addressing prevention, detection, and cleanup of oil spills. Lining, diking, and buffer zones are required to separate oil storage facilities from aquatic habitats.
- Reduce effects on sport fisheries.

e. Effects on Birds

The study area provides critical habitat for numerous species of birds (Chapter Three). Effects of industrial activities on birds depend on the individual species, time of the year, age or reproductive state of the birds, and type of activity. Potential effects in the study area are more likely to occur after the exploration phase, as few resident species are present during winter when most of the exploration would occur. Effects would depend on: distance from the disturbance; type, intensity, and duration of the disturbance; and other factors. Cumulative adverse effects on birds from oil and gas activities could result from: direct habitat loss, barriers to movement, collision with structures, noise and disturbance during nesting and brood rearing, and oil pollution of the terrestrial and aquatic environments.

Habitat Loss: Direct habitat loss could occur from clearing vegetation or filling wetlands for facilities such as drill pads, roads, and oil storage facilities. These facilities could eliminate or alter some preferred bird habitats such as wetlands. Some loss of habitat could also occur from building ice roads for winter exploration, but this would generally be temporary. Breeding birds that occupy areas to be developed would be displaced to suitable habitats in adjacent areas. The effects on local populations of terrestrial birds in the study area due to the loss of small amounts of habitat from roads and pads would not be expected to adversely affect any of the local bird populations, considering the amount of habitat available.

To mitigate the impacts to birds from habitat loss, licensees must identify and avoid sensitive habitats and locate facilities outside of key wetlands. Permanent facilities must be sited at a minimum distance (500 ft. to ¼-mile) from waterbodies to minimize effects on waterbirds. Surface entry near trumpeter swan nesting areas may be prohibited during the summer months, and permanent facilities may be prohibited within one-quarter mile in these areas to avoid displacement of swans.

Noise and Disturbance: Noise and disturbance that may affect birds include: seismic surveys (surface explosions), construction of roads and pads, vehicle traffic, aircraft overflights, and drilling and production activities. Responses of birds to human disturbances (including aircraft) are highly variable and depend on: the species; the physiological or reproductive state of the birds; distance from the disturbance; type, intensity, and duration of the disturbance; and many other factors.

Repeated low-level aircraft overflights could cause some nesting birds to flush and expose eggs to chilling or predation. Aircraft overflights could also cause disturbance of concentrations of feeding, molting, or staging waterfowl in lakes and other wetlands, which might reduce the ability of these birds to acquire the energy necessary for successful migration. If such disturbances occurred frequently, it potentially could affect migration, mortality, and winter survival of affected birds (MMS, 1995).

Trumpeter swans are believed to be sensitive to human disturbance on their breeding grounds. Intrusions by humans on nesting grounds have caused temporary and permanent abandonment, as well as movement from breeding or staging areas (Banko, 1960; Bangs et al., 1982; Belanger and Bedard, 1989). Henson and Grant (1991) studied the effects of human disturbance on Trumpeter Swans. The results indicated that regular aircraft overflights and passing road traffic did not cause incubating females to leave the nest. Swans were more sensitive to the noise and visible presence of stopped vehicles, pedestrians, and researchers. Such disturbances lead to frequent absences by incubating females, uncharacteristic brood movement, and significant behavioral changes. These responses could lead to a decrease in productivity due to increased egg and hatchling mortality, plus additional stress on the already energetically-stressed females.

Bald eagles nest from mid-February until mid-September. During nest building, incubation, and the first five weeks of nestling life, it is critical to prevent eagles from abandoning their nests due to human activity. Certain activities are known to cause bald eagles to abandon their nests including increased noise intensity and disturbance of the nesting area. Present laws protecting the bald eagle include the Migratory Bird Treaty Act, the Bald Eagle Act of 1940. Violations of the Eagle Protection Act can result in fines up to $250,000 and/or imprisonment up to two years (Rappoport, 2000).

Gas Blowouts: In the event of a natural gas explosion and fire, birds in the immediate vicinity could be killed or displaced. Blowouts of natural gas condensates that did not burn would be dispersed very rapidly at the blowout site thus, it is not likely that toxic fumes would affect birds or their food sources except those very near to the source of the blowout (MMS, 1996b: IV.L.2).

Oil Spills: Prevention of and responsive countermeasures to oil spills are particularly critical to assure protection of birds. Direct oil contact is often fatal and oil spills in aquatic environments can results in substantial mortality to birds. Oiling of birds causes death from hypothermia, shock, or drowning. The direct effect of oil on a bird is to clog the fine structure of its feathers, which are responsible for maintaining water-repellence and providing heat insulation. The loss of thermal insulation, especially in cold climates, results in greatly increased metabolic activity to maintain body temperature. Birds also ingest oil in attempting to preen oil from their plumage (NRC, 1985). Some species (e.g., harlequins) can also ingest oil by eating oiled prey (EVOSTC, 1996). Relatively small amounts of ingested oil can cause a temporary depression of egg laying and reduce the hatching success of those eggs that are laid. Oil deposited on eggs from the feathers of the adults can also have an adverse impact on hatching, even in small quantities. The birds most susceptible to oiling are those, which are gregarious, spend most of their time on the water, and dive rather than fly up when disturbed (NRC, 1985).

Bald eagles may encounter floating oil while preying on fish and oil-contaminated carcasses. Oil is also ingested through preening and can be taken back to the nest to oil eggs and young. Surveys taken in 1989 following the Exxon Valdez Oil Spill (EVOS) indicated that nest failure was 85 percent in oiled areas, compared to 55 percent in lightly oiled or unoiled areas. In 1990, increases in bald eagle breeding success suggested that the setback to eagle reproduction was temporary. Researchers estimate that the bald eagle population had nearly recovered by 1994 (EVOSTC, 1994), and an aerial survey of adults in 1995 indicated that the population had returned or exceeded its pre-spill level in Prince William Sound (EVOSTC, 1996).

The number of birds impacted by a spill would depend on the time of year, the extent of the spill, the size of the aquatic habitat affected, and the density of local bird populations.

If oil development occurs, some alteration of bird habitat and disturbance of birds present during oil-related activities can be expected. However, with state and federal government oversight, and implementation of applicable mitigation measures, any oil spill cleanup activities within the study area should not prevent overall bird population levels from remaining at or near current levels.

Mitigation Measures

The following are summaries of some applicable mitigation measures designed to mitigate potential impacts to birds. For a complete listing of mitigation measures and licensee advisories see Chapter Seven. Additional, site-specific and project-specific mitigation measures may be imposed as necessary if exploration and development take place.

- Habitat Loss Avoidance – Licensee must identify and avoid sensitive habitat areas and site facilities outside of key wetlands. Facilities must be sited at least 500 ft. from streams and waterbodies.
- Nesting Area Avoidance – Should development occur in an area where nesting Trumpeter Swans are present, surface entry may be prohibited in the summer months and the siting of permanent facilities may be prohibited in the vicinity of the nesting sites.
- Oil Spill Prevention and Control – Licensees must prepare contingency plans addressing prevention, detection, and cleanup of oil spills. Lining, diking, and buffer zones are required to separate oil storage facilities from aquatic habitats.

f. Moose

Moose are present throughout the study area. Calving and wintering habitat are considered particularly critical. Lowlands support relatively high concentrations of calving moose, and riparian habitat along river drainages constitute essential moose wintering range.

Habitat Loss: Vegetation clearing and construction of roads and pads in the study area could result in a direct loss of some moose habitat. Loss of winter habitat along riparian habitats would be the most important to local moose populations. Some habitat loss may also occur from the displacement of animals around field facilities. Moose movement to critical areas, such as wintering areas, would not be expected to be adversely affected.

It is likely that oil and gas exploration and development would result in some increase in habitat loss beyond that which is already occurring due to other development. However, given the amount of overwintering and calving habitat in the study area, impacts to moose populations are expected to be minimal.

Road Development: The greatest concern regarding moose populations is road development. Road development increases access and typically results in increased harvest. Harvest of bull moose within the MFMA is currently estimated at maximum sustained yield. Any additional harvest could affect subsistence hunting of moose and jeopardize the general season hunt resulting in less moose hunting opportunity for nonsubsistence hunters.

Noise and Disturbance: Noise and disturbance that might affect moose include: seismic surveys; construction of facilities such as roads, pads, and pipelines; vehicle traffic; aircraft overflights; and drilling and production activities. Increased roads and vehicle traffic would also result in increased mortality from collisions. Increased disturbance during the winter months could result in increased energy expenditures and reduce reserves needed for survival. Avoiding winter moose concentration areas can reduce impacts to moose. Moose can adapt to certain levels of activity over time, and the overall effects of increased noise and disturbance are not expected to adversely affect local moose populations.

Gas Blowouts. If a natural gas explosion and fire occurred moose in the immediate vicinity could be killed or displaced. Blowouts of natural gas condensates that did not burn would be dispersed very rapidly at the blowout site thus, it is not likely that toxic fumes would affect animals except those very near to the source of the blowout.

Oil Spills: Oil spills in the study area would not be expected to affect more than individual animals, localized habitat or, potentially, some food sources. Some oil could be ingested through eating contaminated foods or ingestion through grooming. However, with state and federal government oversight, and implementation of applicable mitigation measures, the effect of oil spills would be expected to be negligible to the moose population in the study area.

g. Bears

Black bears are common in the study area, taking advantage of the varied vegetation types and the abundance of other wildlife species, especially in the riparian and wetland areas. Brown bears are also present, but in low numbers (ADF&G, 1992:A-12). Both species could potentially be adversely affected by oil and gas activities.

Habitat Loss: Exploration and development activities could result in direct habitat loss from construction of roads and related facilities, and subsequent fragmentation of habitat. The availability of protective cover is considered important in how bears are influenced by human activities. Brown bears require large blocks of wilderness habitat and travel corridors connecting them. These movement corridors provide secure cover so bears can safely travel to and from important habitats. Oil and gas activities can affect individual bears by increasing their disturbance responses or displacing them from the critical habitat. Under Mitigation Measure 21 licensees must prepare bear interaction plans.

Avoidance of important salmon streams when fish are present would minimize the displacement of bears from this critical habitat. Mitigation Measure 22 prohibits the siting of facilities within 500 ft. of all fishbearing waterbodies.

Noise and Disturbance: Bears may be subject to disturbance from oil and gas activity. Primary sources of disturbance include seismic activity, vehicle traffic, and aircraft overflights. Seismic activity that occurs in winter may disturb denning brown bears up to 1.2 miles from the activity, based on movement recorded from radio-collared bears in their dens (USDOI, 1987). Two incidents in 1998 involving seismic crews on the Kenai Peninsula walking in close proximity to brown bear dens resulted in den abandonment. In one of the incidents, the seismic worker was fatally mauled (Fink, 1996). Avoidance of known denning sites by at least ½-mile would reduce the chance of disturbance to denning bears.

Road Development: The greatest concern regarding bear populations is road development. Road development increases opportunities for bear-human interactions and reduces the value of the bear habitat. New roads could increase mortality rates through increased bear/human encounters. Roads also increase human access to bear habitat for both legal and illegal hunting (ADF&G, 1998).

Bear/Human Interactions: During exploration, development, and operation, human activity may attract foraging bears, especially to refuse disposal areas. Both black and brown bears are attracted to food and garbage associated with human activity, and may become conditioned to non-natural food sources (Baker, 1987). The conditioning of bears to human food sources may pose a safety threat and the potential need to destroy "problem" animals (ADF&G, 1998). Increased bear/human interactions due to encroachment into bear habitat can also lead to increases in killing bears in defense of life and property. Implementation of bear interaction plans and field personnel training would minimize conflicts between bears and humans.

Gas Blowouts. Impacts on bears of a gas blowout would be similar to that of other terrestrial mammals. If a natural gas explosion and fire occurred on land or very near the coast, bears in the immediate vicinity could be killed or displaced. If a blowout occurred blowouts of natural gas condensates that did not burn would be dispersed very rapidly at the blowout site thus, it is not likely that toxic fumes would affect animals except those very near to the source of the blowout (MMS, 1996b: IV.L.2).

Oil Spills: Oil spills can affect bears by direct contact, ingesting oil from grooming, eating oiled prey items, and displacement from critical areas as a result of oil spill response activity. Individual bears could be affected by an oil spill; however, with state and federal government oversight, and implementation of applicable mitigation measures, impacts to the Nenana basin bear populations would not be expected.

Overall effects of oil and gas activities on brown and black bears in the study area would relate primarily to the disturbance to bears and some increased mortality from bear/human encounters. While individual bears might be impacted, there would most likely not be any adverse effects to the regional brown or black bear populations.

h. Effects on Furbearers and Other Small Mammals

Numerous species of furbearers are found in the study area, including: wolf, lynx, wolverine, red fox, ermine, mink, river otter, marten, beaver, snowshoe hare, and muskrat, among others.

Habitat Loss: The effects of direct habitat loss on these species would be negligible. The abundance of wolves and other predators in the study area is ultimately determined by the availability of prey and game management re-location efforts. The ability of adults to provide food is the key determinant in survival of the young. Reduction in prey species would reduce predator populations (USDOI, 1987).

Noise and Disturbance: Most of these species are unlikely to be adversely affected by development within the study area. Primary sources of disturbance are seismic activities and aircraft overflights. Helicopters generally invoke a stronger response from wolves and other predators than fixed-wing aircraft. Ice roads connecting well sites and supply areas would provide a source of vehicle disturbance. Impacts of seismic exploration and drilling on these species are unknown (USDOI, 1986), although they are likely to result in some temporary disturbance in the vicinity of these activities.

Attraction of animals to garbage and other waste can also result in adverse impacts to individual animals. Proper disposal methods would minimize attraction of foxes and other small mammals. See Mitigation Measure 17 in Chapter Seven.

Gas Blowouts. Impacts on furbearers and other small mammals from a gas blowout would be similar to that of other terrestrial mammals. If a natural gas explosion and fire occurred on land or very near the coast, animals in the immediate vicinity could be killed or displaced. Blowouts of natural gas condensates that did not burn would be dispersed very rapidly at the blowout site thus, it is not likely that toxic fumes would affect animals except those very near to the source of the blowout (MMS, 1996b: IV.L.2).

Oil Spills: The general effects of an oil spill on these species would be similar to that of other terrestrial animals. The potential effects of oil spills include contamination of individual animals, contamination of habitats, and contamination of some local food sources. Predators, particularly foxes, may be attracted to dead oiled-wildlife at a spill site. Foxes and coyotes may be attracted to the human activity at a spill site by the possibility of finding food or garbage. In the event of a large oil spill contacting and extensively oiling habitats in wolf or fox concentration areas, the presence of humans, along with vehicle and aircraft traffic, are expected to cause disturbance and displacement of these animals during cleanup operations. However, with state and federal government oversight, and implementation of applicable mitigation measures, impacts to populations of these species in the study area are expected to be minimal.

Mitigation Measures

The following are summaries of some applicable mitigation measures designed to mitigate potential impacts to terrestrial mammals. For a complete listing of mitigation measures and licensee advisories see Chapter Seven. Additional, site-specific and project-specific mitigation measures may be imposed as necessary if exploration and development take place.

- Habitat Loss Avoidance – Exploration activities must be supported by air service, ice roads, winter roads or winter trails, existing road systems, or by vehicles that do not cause significant damage to the ground surface or vegetation. Construction of permanent roads for exploration in most instances is prohibited, and use of gravel filling for exploration is discouraged. Facilities must be sited at least 500 ft. from fishbearing waterbodies. Pipeline Siting - Whenever possible, onshore pipelines must utilize existing transportation corridors and be buried where soil and geophysical conditions permit.
- Exploration Facilities Siting – These facilities must be consolidated, temporary, and not constructed of gravel, in order to minimize habitat loss and creation of new, permanent access.
- Waste Management – Licensees must use appropriate methods of garbage and putrescible waste disposal to minimize attracting foxes, bears, and other mammals.
- Oil Spill Prevention – Licensees are required to implement oil spill prevention, control, and countermeasures plans. In addition, they are required to: site facilities away from lakes, streams, and critical wetlands; provide adequate protection for onsite oil storage; and locate pipelines to facilitate oil spill cleanup.
- Disturbance – For projects in close proximity to areas frequented by bears, Licensees must prepare and implement bear interaction plans. Operations can be designed to minimize conflicts between bears and humans and minimize attraction of bears to facilities and work camps

- Den Site Protection – Before fieldwork can begin, known locations of bear den sites must be identified and avoided by one-half mile during denning season. If new dens are encountered in the field, they must be immediately reported to ADF&G.

2. Effects on Subsistence Uses

The subsistence resources of the study area represent a significant value to the customary and traditional way of life, as well as income and personal enjoyment, for the residents of the area. Subsistence includes the social activities of consuming, sharing, trading and giving, cooperating, teaching, and celebration among members of the community. Of major concern from a subsistence standpoint are moose. Birds, particularly ducks and geese, are also important. Furbearers provide a cash income and raw materials, particularly lynx, marten, wolf, wolverine, beaver, muskrat, and weasel. Fish are important food for humans and dogs, particularly salmon (sockeye, coho, and chinook), pike, and whitefish. The collection of berries, edible plants, and wood, and the production of crafts and tools made from these wild resources, are also of great value.

Community well-being depends on the continued use of subsistence resources because they are culturally and economically significant. Subsistence, with its associated values of sharing food and its influence on the extended family and traditional knowledge, is considered an integral part of life. In addition to this cultural component, subsistence is a direct source of economic well being for area residents. Subsistence resources enter into household income as a food source that does not have to be purchased. A loss of subsistence resources would represent a loss of income for the entire community (Fall, 1993). Any action which disturbs the land or its vegetative cover, the quality or quantity of water resources, wildlife or fish populations, or human or animal access routes may have an impact on subsistence uses.

Reasonably foreseeable indirect effects of oil and gas development on subsistence uses may include: increased access to limited resources by competing users, land use limitations and restrictions on access to subsistence, and the immediate effects of oil spills. Any reduction in local fish and wildlife populations or availability, particularly at critical times of the yea, due to development could result in increased travel distance and hunting time required to harvest resources, potential reductions in harvest success rates, and increased competition for nearby subsistence resources. The development of more transportation corridors in support of oil and gas development in the study area could increase human access to the study area, which could result in increased hunting pressure. A potential indirect benefit of oil and gas development includes an increase in wage earning opportunities to supplement subsistence activities.

Another concern to local residents would be the adverse effects of an oil spill on fish. Fish, such as salmon, northern pike, trout, sheefish, whitefish, burbot, or Arctic grayling, present in portions of the study area could be affected by an oil spill resulting in decreased populations and reduced harvests. Fishery resources could be directly damaged, or made less accessible to subsistence fishers by restrictions to fish movement, changes in migratory patterns, or reductions in water quality. Contingency plans are required for all operations to insure quick response and cleanup of any spilled oil.

If fish resources are reduced of damaged by any cause (natural or as a result of human activity), the ADF&G commissioner, through emergency order authority, or the Alaska Board of Fisheries may take conservation actions that will reduce the opportunity to take fish. Restrictions on the subsistence fishery would degrade the opportunity, and social and economic benefits, described in the Subsistence section in Chapter Four. Effects on subsistence fish resources could occur both within and beyond the study area since some fish stocks that use the study area are part of subsistence fisheries beyond the study area.

As development-related facilities increase, areas could be closed to public access, reducing the area available for subsistence activities, although restricted access must be justified in the plan of operation. If subsistence hunters are displaced from traditional hunting areas, they might have to travel greater distances and spend more time harvesting resources. At the same time, increased public access to hunting, fishing, and trapping areas, due to construction of new roads, could increase competition between user groups for subsistence resources. If competition for scarce resources, like moose, in the study area were to increase, game managers could restrict non-subsistence hunting and fishing. Licensees are required to cooperate with agencies and the public to minimize disruption of subsistence activities.

Impacts on subsistence from oil and gas exploration, development, production, and transportation depend on mitigation measures, operator and licensee company policies, and applicable wildlife conservation and protection laws. All plans of operations proposals (approval of which is required before any exploration or development activity can begin) are reviewed for consistency with applicable laws, including the local government management plans.

Mitigation Measures

Reducing impacts to subsistence resources from oil and gas development is a primary consideration in planning for an exploratory license. Any activity that has the potential to harm fish or wildlife has the potential to affect subsistence. Mitigation measures have been designed to avoid, reduce, or minimize biological alterations to the study area. All or some of these measures may be required for any operation.

The following are summaries of some applicable mitigation measures designed to mitigate potential impacts to resources and subsistence uses. For a complete listing of mitigation measures and licensee advisories see Chapter Seven. Additional, site-specific and project-specific mitigation measures may be imposed as necessary if exploration and development take place.

- Unrestricted Access – Restriction of public access to, or use of, the licensing area due to oil and gas activity is not permitted, except within the immediate vicinity of drill sites, buildings, and other facilities. Any area of restricted access must be justified in the plan of operations.
- Oil Spill Prevention and Response – Contingency Plans are required for all operations addressing the prevention, detection, and cleanup, of releases of oil. They require facilities to be located away from lakes, streams, and critical wetlands to protect from oil stored onsite and pipelines to be located to facilitate oil spill cleanup. In addition, Contingency Plans must include: methods for detecting, responding to, and controlling blowouts; location and identification of oil spill cleanup equipment; location and availability of suitable alternative drilling equipment; and a plan of operations to mobilize and drill a relief well.
- Site Access – Construction of permanent roads is prohibited during the exploration phase.
- Harvest Conflict Resolution – Licensees are required to cooperate with agencies and the public to avoid conflicts by selecting alternative sites or implementing seasonal restrictions on certain activities, and by siting permanent facilities at least ¼-mile from major from rivers, and at least 500 ft. from fishbearing waterbodies.
- Community Participation – Residents can provide critical input and traditional knowledge for operations and oil spill prevention and response plans. Plans of operation submitted for review and approval must describe the licensee's efforts to communicate with local communities, and interested local community groups, if any, in the development of such plans.

3. Effects on Cultural and Historic Uses

a. Resources and Regulatory Framework

Cultural and historic resources are those sites and artifacts having significance to the culture of the people within the Nenana basin. ADNR, Office of History and Archaeology, maintains an inventory of cultural resources, including objects, structures, buildings, sites, districts, and travel ways within the region through the Alaska Heritage Resources Survey. Historical and cultural resources identified in the study area include: isolated Native villages and gravesites, cabins, fish camps, mine sites, and transportation and mining-related sites. Information regarding important cultural and historic sites can be obtained by contacting ADNR, Office of History and Archaeology.

ADNR researched available sources and found 31 known historic and archaeological sites within the study area. The majority of the reported sites within the area exist along the rivers and their tributaries, and the lakes of the region. The setting of the area, however, suggests a high potential for the discovery of additional sites.

State policy on these resources is reflected in AS 41.35.010: "It is the policy of the state to preserve and protect the historic, prehistoric and archaeological resources of Alaska from loss, desecration and destruction ...." Existing statutes, which apply to both known sites and newly discovered sites, are:

AS 41.35.200(a) prohibits a person from unlawfully appropriating, excavating, removing, injuring or destroying any historic, prehistoric, or archaeological resources of the state. "Historic, prehistoric, or archaeological resources" include" deposits, structures, ruins, sites, buildings, graves, artifacts, fossils, or other objects of antiquity which provide information pertaining to the historical or prehistorical culture of people in the state as well as to the natural history of the state." AS 41.35.230(l). Violators of this statute are subject to criminal (misdemeanor) penalties and civil penalties (fines up to $100,000 per violation). AS 41.35.210, 215.

AS 41.35.200(c) prohibits the unlawful destruction, mutilation, defacement, injury to, removal of or excavation of a grave site, tomb, monument, gravestone, or other structure or object at a grave site, even if the grave site appears to be abandoned, lost, or neglected. Violators of this statute are subject to the same penalties listed above for AS 41.35.200(a) [historic, prehistoric and archaeological resources].

b. Potential Impacts

Cultural resources are subject to naturally occurring impacts from weather and other erosive processes. Prehistoric and historic archaeological resources could be affected by activities associated with installation and operation of oil and gas facilities, including: drill pads, roads, airstrips, pipelines, processing facilities, and any other ground-disturbing activities. Damage to archaeological sites can include: direct breakage of cultural objects; damage to vegetation and the soil thermal regime, leading to erosion and deterioration of organic sites; and shifting or mixing of components in sites resulting in loss of association between objects. Impacts include disruption of culture and disturbance of historic and archaeological sites. Crews at archaeological or historic sites could also damage or destroy sites by collecting artifacts (USDOI, 1986). Potential impacts to these resources from oil and gas exploration and development could occur during the exploration, development, or production phases, but are more likely to occur during oil and gas development activities.

Oil Spills: Oil spills can have an indirect affect on archaeological sites by contamination of organic material, which would eliminate the possibility of using carbon dating methods (USDOI, 1986). The most important understanding obtained from past, large-scale oil spill cleanups is that archaeological resources generally were not directly affected by the spilled oil. Following EVOS, the greatest effects came from vandalism, because more people knew about the locations of these resources and were present at the sites. The detrimental effects of cleanup activity on these resources during EVOS were minor because the work plan for cleanup was constantly reviewed, and cleanup techniques were changed as needed to protect archaeological and cultural resources (Bittner, 1993). Various mitigation measures used to protect archaeological sites during oil-spill cleanups include: avoidance (preferred), site consultation and inspection, onsite monitoring, site mapping, artifact collection, and cultural resource awareness programs.

Cumulative effects on archaeological sites from oil and gas exploration, development, and production are expected to be low. In the event than an increased amount of ground-disturbing activity takes place, state and federal laws and regulations should mitigate effects to archaeological resources. The expected effects on archaeological resources from an oil spill are uncertain, but data from EVOS indicated that less than 3 percent of the resources within a spill area would be significantly affected (MMS, 1998).

Well Blowout or Explosion: Disturbance to historical and archaeological sites might occur as a result of activity associated with accidents such as an oil or gas well blowout or explosion. Archaeological resources in the immediate vicinity of the blowout might be destroyed, and cleanup activities could result in disturbance by workers in the vicinity of the accident site.

Mitigation Measures

The following are summaries of some applicable mitigation measures designed to mitigate potential impacts to cultural resources. For a complete listing of mitigation measures and licensee advisories see Chapter Seven. Additional, site-specific and project-specific mitigation measures may be imposed as necessary if exploration and development take place.

- Education – Licensees are required to conduct training for all employees and contractors on environmental, social, and cultural concerns in the area of activity.
- Protection of Historic and Archaeological Sites – Prior to exploration activities involving ground disturbance, and subsequent development, Licensees must conduct an archaeological inventory. If any objects are discovered at any time, they must be reported, and appropriate protective measures followed.